July 12, 2012

Solar House Project

What do you know about solar home?

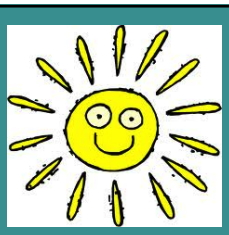
Vocabulary

HVAC- Acronym that stands for "heating, ventilating, and air conditioning", which is an area of design and research for civil engineers.

Insulation- Material that prevents the transfer of heat

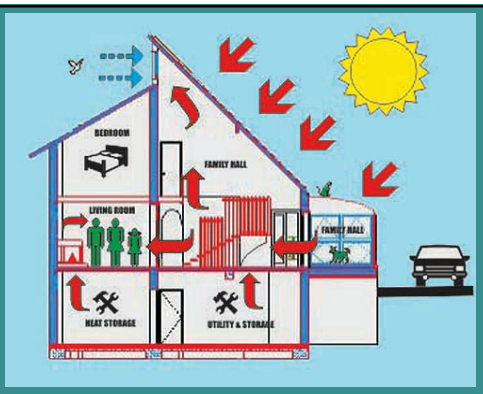
Passive Solar Design- Using the sun's energy, the geographical climate, and the properties of different materials to heat and cool buildings.

Thermal Mass- Construction materials incorporated into passive solar design because of its high heat storage capacity. Possible materials include floors and walls made of concrete, tile, brick, masonry, stone, soil and water.



Imagine if we could heat houses without the use of ANY electrical or gas heaters! Think about the positive effects it would have on people all around the world. Millions of people would be able to stay warm all through the winter, save money on energy bills, and lower the greenhouse gas emissions. Interest in passive solar design is growing rapidly because of the increasing cost of energy as well as growing concerns about global climate change. This has inspired engineers to develop new techniques for passive heating and cooling that can be more easily incorporated into existing buildings and homes.

Passive solar offers the cheapest up-front costs, best reliability, easiest maintenance. Engineers combine passive solar heating with conventional methods to reduce the need for energy-guzzling heating appliances.



Its been around for centuries. Native Americans who lived in harsh desert locations built partially underground homes that kept them cool during the day and warm at night. They also built adobe homes in cliff-side caves that were chosen because the winter sun warmed them & the summer sun couldn't reach them. Today, engineers are expanding these ideas to the many and varied homes that we all live in, so we can be efficient in our energy usage & save some money on our heating bills.

Good passive solar design equal excellent insulation. This is true for any HVAC system, but it is especially important in passive design because passive solar heating does not produce as much heat as conventional methods. So — it is important that the heat produced is not wasted. While a number of materials exist to create well-insulated walls, ranging from spray-on foam to hay bales, it is important to remember to insulate the other parts of your house — all the places that separate the inside from the outside. These places include the roof/ceiling, and windows and doors. For example, windows let considerably more heat escape to the outside than the walls of your home.

Windows are another important component of passive solar designs. You don't want to have too many windows for a good passive solar design. On the other hand, while a windowless building would have the best insulation, would you want to live in it? Rather than eliminate windows altogether, you can install high-quality, double-pane windows and place them in strategic locations. Double pane windows are much better insulators than single pane ones. (In fact, engineers have designed many types of high-tech windows that are helpful for good passive solar design.) For heating purposes, windows are best placed primarily on the equator-facing wall so that they can let sunlight in. Windows, placed in the right locations, can bring in the most sunlight without losing too much heat.

Once the sunlight comes into a room, two other aspects of passive solar design become important:

thermal mass- A good thermal mass is a material that can absorb lots of heat and release it slowly when the surrounding temperature starts to go down. A few materials with a high thermal mass are concrete, bricks and water. When used properly, these materials absorb the heat from the sunlight coming through windows and then release that heat throughout the night

surface color- darker colors absorb more sunlight than lighter colors, for passive solar heating, we would want darker colors on the outside and inside of a building

Using windows, darker colors, and thermal masses, we can create a passive solar heating design that warms up a house during the day and keeps it warm throughout the night. The trick comes in finding the right amount of each item to be used and integrating it into a house.

Larger volumes of space need more heat to make the same gain in temperature as a smaller volume. So a smart passive solar design would limit the space that needs heating to as little as necessary.

The final component to remember in passive solar design is the overall orientation of your design elements. Do you know which way the sun comes up and goes down and shines all day long? You must know from which direction the sun shines so you can place your walls and windows intended to capture the sunlight facing in that direction. Also, if you know the regular direction of cold wind, it is smart to position and design the house to block or divert that wind, to minimize it cooling your house (which makes heating it more difficult).

One of the most unique and fun aspects about passive solar heating is that it can be done in almost an unlimited amount of ways. So engineers who design passive solar heating systems can be as creative as they want!

esign Challenge Handout

Zero-Energy Housing Project

Your goal

To design and build a one-bedroom model house within the design constraints, utilizing passive solar heating techniques to warm up the house as much as possible and sustain that temperature as long as possible.

Things to keep in mind...

- Insulation
- Thermal mass
- Size of home (the space needed to be heated)
- Orientation of home (from which directions are the sun and wind coming?)
- Color
- Be creative! (house can be of any design you can imagine and build with given materials)

Design constraints

- Floor size >= 70 square inches
- Roof height >= 4 inches
- Door size must be able to accommodate a thermometer that can be placed entirely inside the middle of the model with the door closed, and be able to be read through a window (find out thermometer dimensions from your teacher)

Materials

- 32 x 20-inch sheet 1/8-inch foam core board
- 1 sq ft thin clear plastic
- 4 sq ft aluminum foil
- 2 sq ft thin rubber
- 2 sq ft black fabric
- hot glue and/or tacky glue
- thumbtacks
- scotch tape
- masking tape

Testing

You will place a thermometer in your model house and then blast your model with a large light bulb (representing the sun) for 8 minutes at an angle of 45 degrees. During this time, you will record the temperature inside your model to see how much it warms up. Then, you will simulate nighttime and record the temperature with the light off and the wind blowing (a fan). This part of the test will show how well your model home retains heat.

nk to Handout

Analysis & Results Worksheet

Zero-Energy Housing Project

Testing Part 1: "During the Day"		Testing Part 2: "During Night"	
Time (minutes)	Temperature (degrees)	Time (minutes)	Temperature (degrees)
0		8.5	
		9	
1			
		10	
2			
		11	
3			
		12	
4			
		13	
5			
		14	
6			
		15	
7			
8			

1. Collect your data and record it in the table, above.
2. Plot your data on graph paper (or using Excel software).
   - Calculate the largest slope for your plot during the daytime. Remember, slope = rise/run
   - Next, calculate the largest negative slope for your plot during the nighttime.
3. Compare your results with other groups. A larger slope during the daytime means great temperature gains, while a larger (less negative) slope during the nighttime means bette sustainability.
4. How did your group's model home results compare to the other model homes?
5. What worked well in your design? What seemed to work well in other groups?
6. What would you change if you had the time and ability to do so?
7. Draw a sketch of your new and improved model home!